



**UNDERSTANDING DISTURBANCE THRESHOLDS
AND OPPORTUNITIES TO ACHIEVE
BETTER OUTCOMES
FOR BOREAL CARIBOU IN CANADA: A PRIMER**

**CANADIAN BOREAL
FOREST AGREEMENT**



**L'ENTENTE SUR LA FORÊT
BORÉALE CANADIENNE**

PREFACE

The National Recovery Strategy for Woodland Caribou, Boreal Population (boreal caribou, NRS; Environment Canada 2012), established a risk-based management threshold of a minimum of 65% undisturbed habitat in each population range, to be applied in boreal caribou range planning and action planning across Canada. The threshold was informed by a scientific assessment that evaluated the contribution of natural (fire) and human (industrial) disturbance to range condition, and the likelihood of varying range conditions supporting self-sustaining boreal caribou populations (Environment Canada 2011). Both the scientific assessment and the NRS recognized that variability in components of this relationship might be attributed to regional differences in response, or to differences in the characteristics of disturbances, but that further work was required to support regional or context-specific disturbance thresholds.

The Canadian Boreal Forest Agreement (CBFA, or “the Agreement”) commits signatories to promote recovery of boreal caribou through regional caribou action planning across Canada. The following primer describes how the national disturbance threshold was derived, and the opportunities that exist to better understand variation in the relationship between disturbance and caribou response at a population level. The primer answers key questions that have been raised about the NRS and disturbance thresholds by CBFA signatories, and sets the foundation for identification of uncertainties that could be addressed by future work.

Relationship to Other CBFA Reports

The Methodological Framework for Caribou Action Planning in Support of The Canadian Boreal Forest Agreement (http://cbfa-efbc.ca/wpcontent/uploads/2015/11/CBFACaribou_guidelinesiteration2_EN.pdf) was developed to guide CBFA Signatories and planning practitioners through consistent caribou action planning across the CBFA implementation area. The primer is intended to support caribou action planning within the CBFA by enhancing understanding of the disturbance threshold, but it does not provide detailed information to guide planning per se.

Questions or Comments

Questions and clarifications regarding this document should be directed to the CBFA Executive Director Aran O’Carroll (aocarroll@borealagreement.ca).

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ABOUT THE CBFA

The CBFA, which was signed in May 2010, includes seven leading environmental organizations, the Forest Products Association of Canada, its 18 member companies, and Kruger Inc. It directly applies to more than 73 million hectares across the country, making it the world's largest conservation initiative. The CBFA represents a globally significant precedent that seeks to conserve significant areas of Canada's vast boreal forest, protect threatened woodland caribou, and sustain a healthy forest sector by laying a foundation for the future prosperity of the industry and communities that rely on it.

Forestry companies currently participating in the Agreement:

Alberta Pacific Forest Industries Inc., AV Group, Canfor Pulp Limited Partnership, Canfor Corporation, Conifex, DMI, Fortress Paper Ltd., Howe Sound Pulp and Paper Corporation, Kruger Inc., LP Canada, Mercer International, Millar Western Forest Products Ltd., Resolute Forest Products, Tembec Inc., Tolko Industries, West Fraser Timber Co. and Weyerhaeuser Company Ltd.

Environmental organizations participating in the Agreement:

Canadian Parks and Wilderness Society, Ivey Foundation, Schad Foundation, Stand.earth, the Nature Conservancy, and the Pew Charitable Trusts International Boreal Conservation Campaign.

For further information on the CBFA, visit www.canadianborealforestagreement.com

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For the Boreal population of Woodland Caribou (i.e. boreal caribou), a strong relationship exists between the extent of habitat disturbance and whether a local population is stable, increasing or decreasing. As the amount of disturbance increases in a local population range, there is an increasing risk that the population will be in decline. For this reason, as part of the identification of critical habitat, the National Recovery Strategy for boreal caribou established a minimum of 65% undisturbed habitat (or 35% total disturbance) in a range as the disturbance management threshold.

In contrast to past approaches - which have generally focussed on managing the impacts of disturbance on a project-by-project basis - a disturbance threshold can be used to manage disturbance levels in a more integrated way, at the scale of a boreal caribou range. This shift represents an opportunity to achieve better outcomes for boreal caribou conservation in Canada.

Despite the potential of disturbance thresholds, there have been a number misunderstandings about their use and the science that supports them. This primer is intended to help advance understanding of disturbance thresholds described in the National Recovery Strategy by answering a number of key questions which have been raised by CBFA Signatories, including:

- » What science informed the management decision to select 65% undisturbed habitat as the disturbance threshold?
- » Why were 500m buffers used and were different buffer sizes tested?
- » How can the CBFA support implementation of the National Recovery Strategy to achieve the recovery goal for boreal caribou?
- » How can we use active adaptive management within CBFA planning to support the implementation of disturbance thresholds?

Disturbance and boreal caribou: understanding the relationship

To enable the effective use of disturbance thresholds, it is critical to understand boreal caribou's response to disturbance, which is complex and multi-faceted. There is growing recognition that conservation efforts must address both the direct and indirect effects of disturbance on boreal caribou.

Highlights:

- ◇ Disturbance thresholds provide a tangible focus for boreal caribou conservation programs and enable land managers to work towards a common objective.
- ◇ The disturbance threshold established in the National Recovery Strategy was supported by a comprehensive assessment conducted by a team of scientists from Canada and the United States.
- ◇ To develop the disturbance threshold, an analysis of different buffers on human disturbances was completed, comparing buffers ranging in size from 100m to 4000m.
- ◇ Buffers represent two core impacts of disturbance on boreal caribou: caribou avoidance of disturbances and the increased risk of predation boreal caribou face when close to disturbances.
- ◇ A buffer of 500 m was selected to best capture these impacts.
- ◇ After comparing boreal caribou population responses to linear disturbances, polygonal disturbances, fire, habitat configuration and high quality habitat, the total amount of disturbance (i.e., buffered human disturbances plus unbuffered fire) was found to best represent the cumulative impacts of disturbance on boreal caribou.
- ◇ The total amount of disturbance was used to establish a disturbance management threshold of 65% undisturbed habitat within each range.
- ◇ This threshold is 'risk-based', meaning that a range with 65% undisturbed habitat is expected to have a 60% probability of supporting a population that is stable or increasing over time.
- ◇ Given that there is variation in habitat and population conditions for boreal caribou across Canada, strategies to support self-sustaining local populations would benefit from enhanced understanding to support effective implementation of the National Recovery Strategy.

Direct effects result when disturbances affect boreal caribou use of habitat (i.e., habitat loss and avoidance of areas due to noise).

For example, the harvesting of frequently used boreal caribou habitat would directly impact boreal caribou by reducing the amount of habitat available.

Indirect effects result when disturbances affect the size or behaviour of the predator and prey populations within or adjacent to boreal caribou ranges. This, in turn, negatively affects boreal caribou populations. For example, disturbance can create forests which are more favorable to prey species like moose and deer. The increase in the number of these prey species leads to an increase in the number of predators such as wolves, which then results in more frequent predation on boreal caribou. Similarly, linear disturbances can create travel corridors for predators, resulting in more efficient movement and increased predation on boreal caribou.

How was the disturbance threshold in the National Recovery Strategy established?

The disturbance threshold established in the National Recovery Strategy was informed by an intensive assessment conducted by a team of scientists from Canada and the United States. Some of the key steps are summarized here to help users understand the process for establishing the 65% undisturbed habitat threshold and the underlying ecological processes the threshold approach represents.

Consideration of habitat use

One of the first steps was identifying which habitats boreal caribou use and which habitats they avoid. Habitat selection models (i.e., resource selection functions) showed that boreal caribou across Canada generally avoided areas with high road densities and recent burns (i.e., those less than 40 years old). They also showed that boreal caribou tend to prefer peatlands.

The results did vary across regions of Canada and some areas had better data than others for understanding habitat use. These findings informed additional analyses and were also used to identify 'high quality habitat' for boreal caribou. High quality habitat was defined as the habitat which had the highest probability of use by boreal caribou.

A range of buffer sizes were tested and 500m was determined most appropriate for representing a 'zone of human influence'

An important step in developing the disturbance threshold was evaluating the effects of adding 'buffers' to human disturbances. **Buffers, in the case of the National Recovery Strategy, are an analytical approach whereby**

What is 'regional variation' and why is it important?

Regional variation is acknowledged in the National Recovery Strategy, but its interpretation can be challenging. Consider the example of house prices in Canada. While we can determine an average national house price, the actual cost of buying a house varies whether you are in Vancouver, Edmonton or Ottawa. The price is influenced by 'regional variation'.

In the case of the National Recovery Strategy, a variety of disturbance types/habitat features were evaluated to determine their influence on caribou based on both national averages and when regional variability was considered (Figure 1). Understanding regional variation allows us to better understand the factors that are affecting caribou, and what we can do about it.

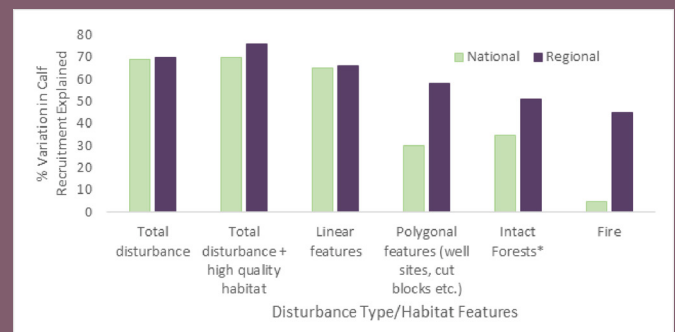


Figure 1. A comparison of how well different variables explained caribou calf recruitment at a national level and when regional variation (represented by ecozones) was considered. *Intact Forests are large, continuous areas of forest undisturbed by human activity, as mapped by Global Forest Watch Canada.

an additional distance (i.e., buffer) is applied to the visible footprint of a disturbance. Buffer sizes are often based on previous studies that have analyzed the distance at which boreal caribou tend to avoid areas (direct effects) or are at increased risk of predation (indirect effects). Thus, buffers represent a 'zone of influence' on boreal caribou.

Buffer sizes of 100m, 250m, 500m, 1000m, 1500m, 2000m, 2500m, 3000m, 3500m and 4000m on human disturbances were examined. Models that included buffer distances of 500m, 1000m, 1500m and 2000m were 1.5 times better (i.e., had higher R² values) at explaining the effects of disturbance on boreal caribou recruitment than models that either had no buffer or a 100m buffer on disturbance.

Based on these results, the 500m buffer was determined to be a conservative choice to account for the direct and indirect effects of disturbance on boreal caribou and was used in subsequent analyses.

Total amount of disturbance in a range had the largest influence on boreal caribou population condition

The next step in establishing the disturbance threshold was exploring which factors had the greatest influence on boreal caribou population condition – as represented by calf recruitment (i.e., number of calves per 100 cows). Calf recruitment was selected for this analysis because it is an indicator of rapid population response to disturbance, and was available for a representative number of regions across Canada. Recruitment was also positively related to adult survival. The analysis looked at how different types of disturbances (e.g., fire, linear, polygonal – well sites, cut blocks etc.), and how high quality habitat and intact forest, affected boreal caribou populations. A secondary objective was to determine whether there was regional variation (see Box 1) in how boreal caribou respond to these factors.

At the national scale, total disturbance within a range (i.e., fire + human disturbances buffered by 500m) explained almost 70% of the variation in boreal caribou recruitment. By comparison, fire alone had a small impact on recruitment, explaining only 5% of the variation in population condition at the national level. However, across regions within Canada the impact of fire on population condition varied considerably, suggesting there are important differences in the characteristics of fire, and in boreal caribou response to fire, in different regions of Canada.

Similarly, there was considerable regional variation in the importance of polygonal disturbances (e.g., well sites, clearings, forest cutblocks) to boreal caribou recruitment. This again suggests there may be important differences in the characteristics of these disturbances, and their effect on boreal caribou population condition in different regions of Canada. In contrast, boreal caribou response to linear features was strongly negative across all regions of Canada.

At a national level, the quantity of high quality habitat did not enhance understanding of boreal caribou population condition beyond that accounted for by total disturbance. However, the amount of high quality habitat did improve

prediction of boreal caribou population condition when regional variation was taken into account, again suggesting that the effect of high quality habitat on boreal caribou population condition may vary across Canada. It should also be noted that characterization of high quality habitat was better in some regions than others.

Given that total disturbance (i.e., fire + human disturbances buffered by 500m) best explained boreal caribou population condition at the national scale, it was selected as the foundation of the disturbance threshold for the National Recovery Strategy.

An integrated approach resulted in a ‘risk based’ disturbance threshold and a minimum requirement of 65% undisturbed habitat within each boreal caribou range

The final step in supporting establishment of the disturbance threshold was integrating the results of the analyses previously described, with additional population information, more specifically, adult survival. This enabled scientists to characterize the probability (or likelihood) of achieving self-sustaining boreal caribou populations relative to the disturbance level on boreal caribou ranges (Figure 1). A self-sustaining population was defined as one showing a stable or increasing population trend over a 20-year period.

To understand the ‘risk based’ disturbance threshold, it’s helpful to first look at discrete thresholds. Discrete thresholds exist when there is an obvious change in the relationship between two variables. For example, as a water balloon fills it reaches a point where the balloon bursts – thus representing a sudden change (or threshold) amount of water the balloon can hold.

In the case of the National Recovery Strategy, there was not a discrete level of disturbance that indicated sustainable versus unsustainable conditions for boreal caribou. Instead, a ‘risk-based’ approach was used to establish a management threshold.

Risk- based thresholds use probabilities to help managers understand the level of risk involved in a management choice. In the case of the National Recovery Strategy, levels of risk were assigned to the comparison between percent total disturbance and the probability that a population would remain stable or increase over time.

The result was a management decision by Environment Canada to select a minimum of 65% undisturbed habitat as the disturbance management threshold for each range.

The 65% undisturbed habitat threshold estimates that a population will have a 60% probability of remaining stable or increasing over time (i.e., a 40% chance of not being self-sustaining) at a level of 65% undisturbed habitat in its range (Figure 2). Undisturbed habitat was defined as the habitat within a boreal caribou range not affected by: a) recent fire (i.e., <40 years) and/or b) human disturbances buffered by 500 metres.

This variability presents an important opportunity. If regional differences in management approaches that result in improved probability of persistence for boreal caribou populations can be identified, it may be possible to achieve ‘better than expected’ outcomes for boreal caribou at similar levels of disturbance. For example, the large amount of regional variation in boreal caribou response to polygonal disturbances (e.g., well sites, cut-blocks etc.) could mean that harvesting strategies, or other management approaches, in some regions of Canada are producing better outcomes for boreal caribou. Similarly, it is possible that regional variation in fire regimes has an important influence on boreal caribou response to fire. For example, severe wildfires may burn a forest completely while other wildfires may result in a mosaic of burned and unburned patches. Whether or not boreal caribou populations are sustained under these conditions may depend on how fire severity affects use of the area by other prey and predators, as well as the availability and quality of food sources for boreal caribou. There may also be regional variation in other factors that influence boreal caribou populations, either directly or indirectly. Factors such as climate variation, differences in forage nutrition, and effects of other human influences on the landscape (e.g., hunting pressure, recreational land use) could also be explored.

There is a need to explore opportunities for further research that could reduce uncertainty and refine the application of the disturbance threshold. This includes taking into account some of the regional variation observed in the scientific assessment that supported the National Recovery Strategy. Specific topics that could be explored include:

- » Understanding how regional variation in the characteristics of forest fires, harvesting patterns, their recovery rates and the configuration of high quality habitat affect the relationship between disturbance and boreal caribou population condition.
- » Exploring how the relative permanence of different types of disturbance (e.g., well sites versus cutblocks) influence habitat recovery trajectories.
- » Testing variable buffer widths for different types of disturbance (e.g., seismic lines vs. roads vs. cutblocks) to observe their impacts on the ability of models to predict boreal caribou population condition.
- » Understanding how habitat restoration activities impact both short and long-term boreal caribou objectives, including when ‘restoration’ of a disturbance is achieved.

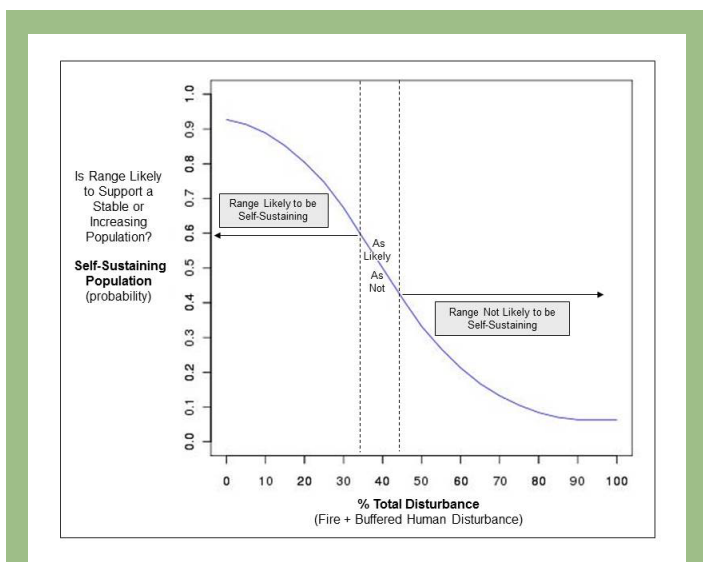


Figure 2. The response surface used to establish the ‘risk based’ management threshold in the National Recovery Strategy. Note that probabilities were used to assess the level of risk for different levels of disturbance in a range.

What opportunities exist to refine the application of the disturbance threshold for use in regional boreal caribou action planning?

The 65% undisturbed habitat threshold used in the National Recovery Strategy is an average value based on an analysis of 24 boreal caribou populations or study areas across Canada, that was then applied to 51 local population ranges. There is a large amount of variability in how individual ranges might respond to implementation of this threshold. For example, some ranges may be at or above the 65% undisturbed habitat threshold but still have declining populations due to other characteristics of the range.

Understanding how these differences affect boreal caribou populations may help to refine implementation of disturbance thresholds and help identify management practices that could result in better than expected outcomes for boreal caribou.

How can the CBFA support implementation of the National Recovery Strategy to achieve the recovery goal for boreal caribou?

The CBFA commits signatories to promote the recovery of boreal caribou and to use the best available information in these efforts. Thus, disturbance thresholds provide an important foundation for current and future planning activities of the CBFA.

A first step for CBFA Signatories is to understand how disturbance thresholds can assist with managing a complex challenge like boreal caribou conservation. Second, CBFA Signatories have an opportunity to help jurisdictions enhance understanding of regional variation in habitat conditions within boreal caribou ranges across the country through provision of forest management data. The National Recovery Strategy acknowledges that there is variation in habitat and population conditions for boreal caribou across Canada. As such, strategies to support self-sustaining local populations would benefit from enhanced understanding to support effective implementation of the National Recovery Strategy.

For More Information

Environment Canada. 2011. Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada: 2011 update. Ottawa, Ontario, Canada. 102 pp. plus appendices.

Environment Canada. 2012. Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. xi + 138pp.

Gonet, J. 2015. Boreal Caribou Response to Disturbance: Results of a 2010-2015 Science Review. Prepared for the Science Committee of the Canadian Boreal Forest Agreement. 36pp plus appendix.

A third way in which CBFA Signatories can support implementation of the National Recovery Strategy is through active adaptive management. The process of active adaptive management supports adjustment of management actions in light of new or improved knowledge and is recognized as critical within the National Recovery Strategy. Conservation efforts could yield the greatest knowledge gains by prescribing a range of restoration and development activities in a way that enables testing outcomes for boreal caribou. Understanding what factors contribute, and why, to a more or less desirable outcome for boreal caribou conservation would significantly improve management effectiveness and reduce risk. Given that most CBFA tenures overlap with boreal caribou range, and represent a wide range of habitat and population conditions and associated risk, there is an unparalleled opportunity to advance understanding of boreal caribou conservation through active adaptive management. This opportunity can be further realized by considering the cumulative effects of multiple resource industries on boreal caribou populations.

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